Click here to view PowerPoint presentation; Press Esc to exit

Human Behaviour Representation - Application Areas

Dr. Uwe Dompke
NC3A, ORFS Division
Oude Waalsdorper Weg 61
2501 CD The Hague
The Netherlands
+31(70) 374 3636
Uwe.Dompke@nc3a.nato.int

Abstract

This paper is taken from the Final report of LTSS SAS-017 on Human Behaviour Representation It gives an overview on the different applications of HBR. It starts with the new military environment. Based on this description the applications in the areas of Instruction, Training and Exercise, Defense Planning, Acquisition and Support to Operations are described. A summary on the importance of HBR is given at the end.

1 Future Military Environment

General. To accurately determine future military requirements NATO's missions must be considered within the context of the predicted future security environment. Even though the security conditions have greatly improved after the end of Cold War, there are still residual risks to the Alliance. Therefore NATO's first mission is still **Article 5 Operations**. These situations comprise all potential threats and risks of armed attack against one or more NATO members. Such situations can range from relatively small sub-regional problems to threats involving more than one NATO Strategic Commander's (SC's) area of responsibility (AOR). Large scale Article 5 Operations on this scale are only considered to be possible after an extended build-up.

In addition new risks have emerged and more can be expected. It is not possible to predict either the time or the place these risks may break out into future conflict. Therefore the future environment will be characterised by variety and uncertainty. Geopolitical changes since the end of the Cold War is forcing NATO to look well beyond its traditional area of responsibility. The focus of geo-strategic analysis must be re-oriented to include all areas where NATO forces might be deployed. Potential crisis regions, their security impact on Alliance nations and routes to these nations are therefore of direct interest to NATO. These missions are called **Crisis Response Operations (CRO).**

CRO operations are composed of

- Peace Support Operations (PSO) and
- Other Security Interests (OSI).

The following sections cover all the different types of CROs NATO may be involved in the future.

Peace Support Operations: PSO are multi-functional operations conducted impartially in support of a UN/OSCE mandate involving military forces and diplomatic and humanitarian agencies and are designed to achieve a long term political settlement or other conditions specified in the mandate. They include peacekeeping and peace enforcement as well as conflict prevention, peacemaking, peace building and humanitarian operations.

Paper presented at the RTO SAS Lecture Series on "Simulation of and for Military Decision Making", held in Rome, Italy, 15-16 October 2001; Stockholm, Sweden, 18-19 October 2001; Virginia, USA, 23-25 October 2001; The Hague, The Netherlands, 10-11 December 2002, and published in RTO-EN-017.

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JUN 2003	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Human Behaviour Representation - Application Areas	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **NC3A, ORFS Division Oude Waalsdorper Weg 61 2501 CD The Hague The Netherlands**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001513. RTO-EN-017, The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**39**	

OSI: Potential threats to Alliance vital interests can result from a number of causes. Such risks are not geographically limited to areas in the areas contiguous and peripheral to NATO territory. These include:

(1) Military significant violation of arms control treaty obligations, including non-proliferation agreements.

(2) Threat to use military force, including coercion.

(3) Acts of terrorism or sabotage affecting Alliance territory.

(4) Disruption of economic lifelines, lines of communication, public service infrastructure by blockade, sabotage or other use of force.

(5) Border violations and incursions as well as hostile violations of Alliance territorial waters and airspace.

(6) Missile or aircraft attack against Alliance members.

(7) Spill over of conflict from beyond NATO's Area of Responsibility (AOR).

(8) Armed attack against forces, vessels or aircraft of any NATO member in NATO's AOR or beyond NATO's AOR during PSO.

Further, although support to UN peacekeeping operations "is not, in principle, geographically limiting, emphasis should nevertheless be placed on geo-strategic aspects relevant to the risk of spill over of crisis and conflicts into the NATO area of responsibility

Regions within these geo-strategic areas, where future NATO-led operations were thought to be possible, were examined to derive a wide range of likely environmental and geographic characteristics under which CRO could be carried out.

Peace Support Operations are undertaken under Chapter VI or VII of the UN Charter and divided into the following types of operations:

Peacekeeping: Peacekeeping operations are generally undertaken under Chapter VI of the UN Charter and are conducted with the consent of all Parties to a conflict to monitor and facilitate implementation of a peace agreement. Possible tasks for peacekeeping operations include observer missions, interposition force operations and transition assistance.

Peace Enforcement: Peace enforcement operations are undertaken under Chapter VII of the UN Charter. They are coercive in nature and are conducted when the consent of all Parties to a conflict has not been achieved or might be uncertain. They are designed to maintain or re-establish peace or enforce the terms specified in the mandate. Possible tasks for Peace Enforcement operations include: enforcing sanctions, establishing and enforcing no-fly zones, protection of humanitarian operations and establishing and protecting safe areas or exclusion zones.

Conflict Prevention: Activities aimed at conflict prevention are normally conducted under Chapter VI of the UN Charter. They range from diplomatic initiatives to the preventive deployment of forces intended to prevent disputes from escalating into armed conflicts or from spreading. Conflict Prevention can also include preventive deployment, surveillance, early warning, and implementation of embargoes in support of sanctions.

Peacemaking: Peacemaking covers the diplomatic activities conducted after the commencement of a conflict aimed at establishing a cease-fire or a rapid peaceful settlement. They can include the provision of good offices, mediation, conciliation and such actions as diplomatic pressures, isolation or sanctions.

Peace Building: Peace Building covers actions, which support political, economic, social and military measures and structures aiming to strengthen and solidify political settlements in order to redress the causes of a

conflict. This includes mechanisms to identify and support structures, which will tend to consolidate peace, advance a sense of confidence and well-being and support economic reconstruction.

Humanitarian Operations: Humanitarian operations are conducted to alleviate human suffering. Humanitarian operations may precede or accompany humanitarian activities provided by specialised civilian organisations. Possible tasks for Humanitarian Operations are: protection and transport of humanitarian aid convoys, maintenance, repair and creation of routes and critical infrastructure, medical support, assistance in the relocation of return of refugees and humanitarian de-mining operations.

Risks of a wider nature are defined in NATO documents as including "international terrorism, radical transnational movements, territorial disputes, disruption of the flow of vital resources and mass migration...the proliferation of WMD in a global as well as European context." For the purposes of the review this information was used to define two categories: Economic and Military-Political. Within each category it was assumed that NATO military forces could be required to execute the following missions:

(1) Economic.

(a) Ensure free movement of vital resources along strategic lines of communication.

(b) Prevent interference with the availability of vital resources (oil, minerals etc.)

(2) Military-Political.

(a) Assist in maintaining regional military-political stability.

(b) Extract NATO member forces engaged in a UN or OSCE-led PSO when threatened with serious aggression.

(c) Execute deterrent actions against states involved in terrorism or terrorism support.

(d) Execute deterrent actions against states involved in the proliferation of and/or potential use of weapons of mass destruction.

(e) Protect NATO territory from the spill over effects (refugees, mass migration, organized crime) of peripheral region instability.

The area peripheral to NATO's AOR should be of primary focus however, since the range of potential Alliance involvement is not in theory geographically limited, an initial worldwide review should be carried out. All areas/regions were assessed to determine those that were possible candidates for a future NATO led CRO. This assessment should be based on the following filtering process:

(1) Potential for political/ethnic/social/economic instability leading to conflict

(2) Existence of regional organisations or alternative support structures that could undertake the operation

(3) Degree of NATO acceptance within the region

(4) UN/OSCE mandate likely

(5) NAC approval likely

In general, the changing in threats to NATO countries drives the need for advanced HBR and the increased emphasis on non Article 5 missions described above. NATO countries no longer exist in a world of blue and red where the major threat to security comes from one block of nations. Instead, NATO faces a difficult to perceive future where the only certainty is change: Changes in threats, changes in adversaries, and changes in the missions NATO forces are expected to accomplish. Against this background the only certainty is that NATO forces must become more flexible and adaptable.

In summary, the future military environment of NATO will most likely be dominated not by Article 5 missions, but rather by CRO missions. This change will severely challenge NATO. NATO will not be able to rely on existing war plans and doctrine (as it does for Article 5 missions), but instead be forced to develop plans and procedures for CRO missions on an as required basis. NATO will have to become more flexible and adaptable, ready to respond to a wide range of possible courses of actions. HBR can help them achieve this goal.

2 Application Areas

There are many potential NATO military applications for HBR. In this section we discuss how HBR may be used to support training and exercises, defence planning, acquisition, and support to operations. As will be seen below, in many of these application areas HBR is a component of some other technology (e.g., modelling and simulation) that is providing support to the NATO activity; in other instances it is a supporting technology in its own right. The discussion is not meant to be exhaustive consideration of military applications for HBR. Rather, it will highlight some of the applications that can be readily foreseen.

In general, the changing in threats to NATO countries drives the need for advanced HBR and the increased emphasis on non Article 5 missions described above. NATO countries no longer exist in a world of blue and red where the major threat to security comes from one block of nations. Instead, NATO faces a difficult to perceive future where the only certainty is change: Changes in threats, changes in adversaries, and changes in the missions NATO forces are expected to accomplish. Against this background the only certainty is that NATO forces must become more flexible and adaptable. HBR can help them achieve this goal

2.1 Instruction, Training and Exercises

Within NATO training and exercises encompasses three sub-areas, namely instruction, training and exercising. The detailed definitions of these terms can be found in chapter 2, para 1. For this discussion, it suffices to retain that instruction and education refers to the acquisition of skills by an individual or group for the ***first*** time. Training follows instruction and is aimed at ***improving the performance*** of individuals and teams at employing their newly acquired skills and knowledge. Exercises follow training; their objective is threefold. Exercises aim at maintaining skills acquired during training at a specified level of performance. They are intended to enable teams and individuals to generalise the knowledge that they have acquired through training. Exercises also develop the knowledge about the conditions in which to best use specific skills.

In the progression from instruction to exercises, the environment that is used to achieve the transfer of knowledge becomes more complex and the understanding about the use of the transferred knowledge increases in the team or individual.

An important aspect of knowledge transfer is the ability to measure performance of the individuals or teams involved in instruction, training and exercising. While performance measurement can be specified and executed well in instruction, it becomes increasingly difficult in training and appears to be ill-specified in exercising. However the quality of knowledge transfer is directly related to the capability to measure performance and provide feedback.

In the new security environment that has emerged over the past ten years, we have seen a rapid change in many NATO nations armed forces. They have transitioned from an army based on conscription to fully professional armed services. This new form of organisation relies on many persons to join the ranks of the armies for short term contracts. However the sustained economic growth has made it difficult for many nations to attract suitable people and at the same time caused a considerable amount of highly skilled and experienced professionals to leave the armed forces. Therefore the need for a sustained training and exercising environment providing a consistent level of knowledge transfer has grown.

At the same time, many operations are conducted on an “ad hoc” voluntary participation basis by nations that place a considerable and sustained demand on limited personnel resources. Since planning for these operations cannot be foreseen and incorporated in planned training and exercise events, the training environment

must highly configurable and composable with the relevant elements in order to prepare personnel participating in these operations effectively. Furthermore, good performance measurement is required to establish the ability of the personnel to carry out their tasks in an often highly visible environment from a political and media perspective. These inherently multi-national operations almost invariably involve non-NATO personnel who are unfamiliar with NATO tasks and procedures and need to be trained and exercised to work together in an effective manner.

Also co-operation with non-governmental and private volunteer organisations has increased considerably. Since the military forces are often responsible for the overall security in the area and for the protection of local populations as well as external organisations, the representatives from these organisations also need to be trained e.g. mine awareness.

It should also be noted that a new problem is emerging as a result of the many parallel operations that are being conducted by forces from NATO nations. Due to the length of these commitments, it is becoming increasingly difficult to ensure that military personnel is trained on the full spectrum of tasks that they are expected to be able to deal with. Therefore, training and exercising is required whilst personnel is deployed and will need to be inherently distributed.

Overall there is a greater need for a training and exercising environment that can be configured rapidly and made widely available to a broader community of people requiring their skills to be developed in a co-ordinated and consistent manner. Also there needs to be greater emphasis on a verifiable level of skill in personnel because the room for error has become extremely small due to the high degree of media coverage and to the stringent and detailed political guidance.

The following sections will focus on the need for formal representations of human behaviour for the processes of instruction, training and exercises. The importance to address the development of such behaviours rapidly will be argued. Section 3.3 will contain the expected benefits of developing formal representations of human behaviour.

2.1.1 Instruction and training

In instruction, material is usually presented by a lecturer or a computer-based tool to an individual and can cover a wide range of topics (e.g., anything from technical training on how to use a specific system to the procedures for Transfer of Authority). Material is absorbed by the individual or group and a number of tests are conducted to verify the acquisition of knowledge or skills. Based on the results of the tests, material is presented again or the trainees can move on to another phase of the instructional process. When the knowledge or skills are considered acquired, training can start. The goal will be to improve the performance of the trainee(s) in applying their new skills and to start the acquisition of meta-knowledge about the conditions of usage of these skills. In order to stimulate the development of meta-knowledge and gather a wider set of measurements, training requires the environment to be more complex and the set of scenario's needs to be more diverse than in an instruction context. Using this description, the following elements can be identified as composing the instructional environment:

- The individual or group of trainees. Their level of knowledge needs to be determined throughout the learning process. It is also necessary to define a reference trainee for performance measurement. The reference trainee can be either an average derived from the performance of previous trainees, an internal reference, or an ideal trainee defined by a set of experts, an external reference.

- The entities that the trainee(s) interact with, from a physical and mental perspective

    - Inanimate systems

    - Individuals: team members, leaders, subordinates, opponents, bystanders

    - Teams: well organised, goal-orientated individuals, displaying a high degree of cohesion and mutual support

- Groups of individuals: loosely cohesive, temporary groups of individuals e.g. crowds

- Organisations: subordinates, superiors, peers, opponents, NGOs, PVOs, governmental elements, media

- Platforms operated by humans

These entities should behave in a consistent and reproducible manner to provide all trainees with a verifiable and objectively measurable level of performance. They need to be fully interoperable at equivalent and different levels of granularity, allowing the designers of the knowledge transfer task to configure the instructional environment in the most effective manner. From a technical perspective they need to be able to operate in a distributed environment over large distances.

- The instructor who manages the knowledge transfer process by controlling the presentation and illustration of instructional material, the steps taken by the trainees in acquiring knowledge and who measures the performance of trainees.

A good instructor will adapt the instructional strategy to the background and to the progress that the trainees are making. It is also necessary that the instructor behave in a consistent manner regardless of the trainee(s) especially when measuring the performance of trainee(s) and judging their progress. The instructor contains a repertoire of teaching strategies and a representation of an expert's knowledge to teach both domain knowledge and expert problem solving strategies.

From a technical perspective, the instructor should be able to operate on the equipment used by the trainee and intervene with it to provide the trainee with a continuous ability to maintain skills and call upon remedial training when required. Hence the instructor should be able to transition from its initial knowledge transfer function to a coaching and assistant role when the trainees starts to perform the newly acquired tasks in his or her working environment.

Automated representations of human behaviour of the elements described above are necessary to improve computer-assisted instruction, specifically the form of instruction known as intelligent tutoring. Traditional computer-based instruction tools use the trainee's response to multiple-choice questions to direct the instructional path. If the trainee performs poorly on a test, instructional material is presented again, usually in a slightly different format. These tools also attempt to anticipate all possible trainee errors and seek to provide appropriate remedial instruction. However, such an approach fails when trainees interpret instructional material in an unanticipated incorrect manner. In this situation, the system cannot generate an explanation that will resolve the student's misunderstanding and the student's learning is impeded. Hence static models of the trainee and of the instructor do not provide a sufficiently flexible and responsive environment. In summary, there is a need for a formal approach to adaptive and interactive treatment of the knowledge transfer process also referred to as adaptive treatment interaction ref. Snow, Stanford.

Automated implementations of representations of the human behaviours described above are essential in achieving the standardisation, objective training, composability and distribution requirements mentioned with each of the representations described above.

In order for NATO staffs to efficiently train, the information they receive and the response of their opponents to their actions should be as realistic as possible. Recent advances in modelling and simulation technology have dramatically improved the presentation and display of information for training purposes. However, these simulation environments rely almost completely on role players for the representation of human behaviour at the level of interaction with the staff being trained. They also neglect to represent the human behaviour aspects for simulated entities. Human role players are usually required in large numbers and therefore poorly qualified to perform their function. Recent training events conducted with fewer professional role players have shown that this can be overcome. However this approach is not sustainable for larger events from a cost perspective. In any case, human role players always introduce implicit bias e.g. risk taking. Formal representations of human behaviour that can be automated are necessary to provide a realistic representation of all human or human-operated entities. These models are required to ensure a consistent quality of training and to enable the use of more complex training scenarios.

2.1.2 Exercises

Exercises are formalized gatherings of a particular command echelon in which trained individuals practice their skills in a wider military context. Exercises may be conducted at strategic, operational, and tactical levels and are intended to assess the echelon's ability to execute selected elements of its mission. As noted in a NATO report on computer-generated forces (reference required), post-Cold War exercises have become more complex due to the lack of detailed contingency plans and the resulting greater effort required for designing exercises. In addition, the range of scenarios that needs to be exercised has increased to an expanded mission set (e.g., peace keeping and humanitarian aiding) and the increased number of agencies and governments that NATO works with (e.g., Private Voluntary Organizations, Non-Governmental Organizations, and Partnership for Peace nations).

For exercises all aspects discussed for instruction and training apply except for the role of instructor. Since the exercising staff is assumed to have achieved a good of level of knowledge, the role of instructor is replaced by the role of observer. Observers will have access to the perception of the exercising staff as well as to the real situation data. Therefore the observer role is capable of assessing performance and of providing feedback. Co-ordination between observers and exercise directing staff is necessary to adapt the flow of the exercise similar to adapting the training strategy in order to meet exercise objectives. In order to provide a consistent observation capability and allow observation to take place for each individual and group participating in an exercise, an automated representation of the observer is required due to the large number of personnel participating in exercises and the many group activities taking place in parallel.

The requirement for automated human behaviours as described in the previous section is also more pressing in an exercise environment because the environment is more complex in terms of numbers and types of entities, the combination of entities of different levels of aggregation e.g. individual leaders, crowds, aggregated military units and the potential requirement of decomposing aggregates to answer specific information requirements.

Compared to training, exercises add the aspect of C3I SYSTEMS interfacing. There are two aspects to this form of interfacing. The first aspect requires the simulation environment to be capable of consuming guidance from the exercising staff and from the exercise control staff and to develop the necessary plans and actions autonomously. Therefore models of the cognitive aspects of the receiving entities need to be represented as well their physiological and socio-affective characteristics. The second aspect is the generation of information from the simulation environment in a form and content that is required and expected by the information systems supporting the exercising staffs. This information is both structured and unstructured, the latter being mainly assessments of situations and intentions. In current simulation environments, a combination of automated interfaces and role players perform these tasks. The automated interfaces tend to support the structured information flow with fixed information pathways. Role players are necessary to generate unstructured information and reconcile inconsistencies in guidance. In order to reduce the considerable amount of role players that is currently required, automated models of human behaviour need to be developed. They are also required to improve consistency.

Furthermore composability and interoperability is necessary to allow the rapid preparation of effective exercise designs, which is becoming increasingly important when responding to unexpected crisis situations.

In view of the complexity of exercises, performance measurement is considerably more difficult and requires data collection to be pervasive. Therefore the development of the automated observer representations discussed above is critical for providing good after-action review.

2.2 Defence Planning

Defence Planning in NATO is the identification of future requirements to address anticipated missions, five to fifteen years in the future. Defence Planning identifies required capabilities to solve future problems; it can be contrasted with Operational Planning, which is concerned with making the best use of available forces to tackle near term problems.

The goal of Defence Planning is to identify military assets capable of responding to a wide range of military situations. Defence planning is subdivided into the following disciplines:

- Force Planning
- Reinforcement Mobility Planning
- Stockpile Planning,
- Civil Emergency Planning
- Command Information System Planning
- Armament Planning,
- Logistics Planning
- Nuclear Planning
- Infrastructure Planning,

Support to Defence Planning within NATO, for the most part, is provided by specialised constructive models. Within NATO, there is currently a range of limited models covering everything from individual platform engagements to force-on-force theatre level campaigns. A recent NATO report on modelling and simulation identified several shortcomings with existing models, primarily in the areas of evaluating new missions, understanding political-military decision-making, and conducting joint operations (reference NATO M&S Report). HBR research will play both a direct and an indirect role in improving NATO defence planning.

One of the most serious gaps in NATO defence planning is the lack of adequate means to evaluate new missions. Since the end of the Cold War, the range of potential NATO missions has expanded considerably (e.g., NATO, collective defence and NATO-Plus, Non-Article 5 missions), as has the range of potential NATO allies and adversaries. This increased range of missions and actors has created a significant need for tools to support concept development and experimentation, particularly in the areas of requirements definition, doctrine development and the tactics evaluation. NATO is looking to advances in modelling and simulation technologies to fill this need. One of the most critical component technologies, as identified by a recent NATO report, is HBR (need reference to NATO M&S report). Advanced HBR models, similar to the types described in the previous section, are required to reduce the cost and increase the realism of the constructive models used by defence planners.

For example, new models are needed to analyse both information warfare and peace support operations. To accurately model the threats and opportunities brought about through advances in the conduct of information operations and warfare will require the development of very high fidelity HBR models of individuals and organisations. Such models will have to depict the flow of information through organisations and the way in which information interacts with individual's belief structures to enable defence planner to understand the possible outcomes of an information operation mission.

To accurately model the challenges of peacekeeping operations will require the development of HBR models of civilian populations and their likely behaviour. In particular, models will need to be developed which incorporate cultural beliefs and attitudes towards other ethnic groups and which predict how civilian populations respond to local conflict. For example, it would be very useful to NATO planners to know how likely a population is to leave their home area when a conflict breaks out and under what conditions they might return.

Furthermore, NATO staffs currently lack tools to analyse the process of achieving political consensus among NATO countries and to estimate the time required by the countries to make to a decision regarding a specific course of action. This lack of tools limits the staff's ability to make realistic or achievable recommendations for proposed courses of action to NATO. The development of sophisticated models of human and organisational decision-making behaviour to address these shortfalls would directly improve the NATO staff's ability to propose acceptable course of action, to anticipate how much time is required to achieve political consensus, and to produce better estimates as to the time require to begin and execute a mission.

In addition, there is a serious lack of models capable of analysing the conduct of joint operations. With respect to HBR, the development of such model should include cultural components or parameters to enable defence planners to better understand cultural difference as they related to command and control and mission

planning and execution. In particular, defence planners could use models for peacekeeping operations, which establish the attitudes, beliefs and relationships between different participating entities or organisations and establish the events and /or criteria that could cause a change in relationship between bodies.

Finally, and most important, Defence Planners have limited in modelling support to forecast possible future security requirements. Models are needed that can predict the political changes in the countries around NATO's periphery. Key issues include:

- What types of governments are likely to become established both in the countries that made up the former Eastern Block and the African and Middle Eastern states (e.g., communist, Islamic, neo-feudal [now based upon business holdings rather than land]);
- What will be the relationships of these countries to NATO;
- What types of threats (if any) will they pose for NATO (e.g., cyber warfare; Missile launched WMD; conventional terrorism); and
- What will be the countries economic status and orientation?

Defence Planning requires a range of new models to include:

- Geopolitical models which enable analysis of the possible evolutionary paths that a country may follow;
- Organisational models of non-government organisations and other entities (e.g., the United Nations); and
- Command and Control models, which enable the analysis of systems that incorporate non-traditional allies and interfaces to other organisational entities.

2.3 Acquisition

New systems are usually acquired to counter a perceived threat. The perception of a new threat by the requirements community typically leads to the generation of a mission need statement and then to a series of analytic studies that attempt to determine the best way to counter the threat. Modelling and simulation are used extensively to evaluate mission needs and requirements, trade-off alternative approaches to countering a threat, and to evaluate the system developed to meet the threat. HBR plays a major role in acquisition, primarily through the support it provides to these simulation-based studies.

In the early phases of system acquisition, studies are conducted to determine the best way to address an emerging threat. Often a change in doctrine, tactics, or operational concepts will be sufficient to overcome a threat. HBR is required to support this process by providing realistic models of decision-making, actor, team, group and organisational behaviour. To the extent that one can improve the HBR models, one will improve the subsequent analysis.

Modelling and simulation is also used to evaluate *alternative* approaches and alternative designs. Modelling and simulation plays an especially important role here because design decisions made at this point account for the vast majority of systems life-cycle costs. Consequently, it is important to thoroughly evaluate design options in the most realistic environment possible.

To adequately address the human's role in weapon system design and to establish and validate the system's operational concept a Human System Integration concept must be established [1] and human-in-the-loop studies must be conducted. These studies are expensive, because they require breadboard or prototype equipment, and they significantly add to the development time for a new a system.

[1] See NATO DRG report on Human Systems Integration (Panel 8 RSG 21)

Furthermore, HBR representations are urgently needed that can be integrated into computer-aided design (CAD) systems. Such models could be used to evaluate the ergonomics and human factors of a design and as a consequence, significantly reduce the development time while simultaneously improving overall system performance. Only HBR models currently exist, which can be used to evaluate anthropometrics (form and fit) aspects of a design. Therefore, the major challenge facing the HBR community is the development of models of cognitive processing which can be used to evaluate cognitive factors such as workload, task allocation between human and machine, and crew sizing and responsibilities. Such models currently exist, but not in a form that can be used in a CAD environment.

Once a design has been selected and prototype (or first article) systems have been built, then modelling and simulation (as well as live test) is used extensively to evaluate the prototype to ensure it meets design specification. Typically, the prototype system is linked or interfaced to a simulation environment where it is repeatedly run through tests. Once again, HBR supports this process by helping to provide both a realistic and cost effective environment in which to evaluate system efficacy.

However, HBR cannot only support the Human Systems Integration but also the whole strategy of military systems acquisition.

This will be explained using the example of SBA.[2] As a result of many factors a sustained and in depth review of the acquisition process has been ongoing for several years leading to the elimination of outdated rules and standards while at the same time revising the process to reflect the realities of the post cold war environment. Today there is a desire to have an acquisition process that is streamlined, enabled by robust collaborative use of simulation technology, integrated across all acquisition phases from concept evaluation, requirements definition, development, manufacture, fielding, to life cycle support and finally disposal. The objective of such a broad thrust is to reduce the time, resources and risk associated with the acquisition process and at the same time increase the quality, military utility and supportability of systems developed and fielded. To carry out such a broad endeavour requires a significant change to the current way the acquisition process is conducted to a new acquisition methodology called Simulation Based Acquisition (SBA). See figure

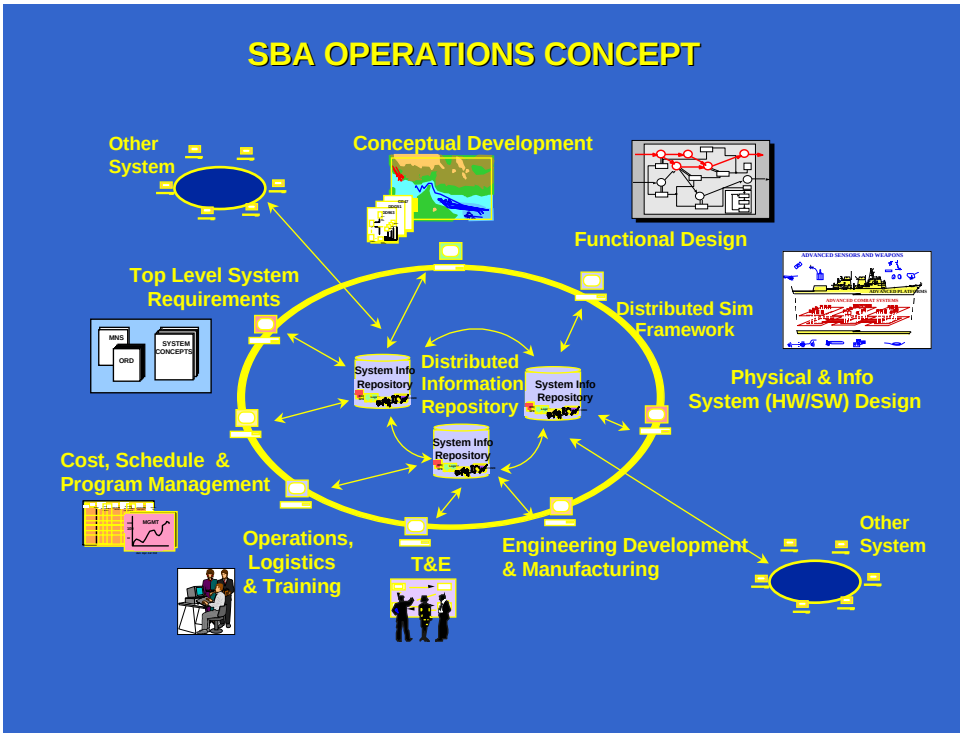


Figure 4: The SBA Operations concept

[2] SBA is the development of a collaborative enterprises that enables interdisciplinary teams to develop new systems in a cost effective manner with a significant reduction in the time it takes to field that system (reduced cycle time).

It is not the purpose here to go into a long dissertation on SBA. However to understand the role HBR plays in SBA it is important to understand a few fundamental requirements necessary for SBA to be efficient and effective. First and foremost is the concept of the collaborative enterprise. The collaborative enterprise *encompasses members* from all phases of the acquisition process including industry. It includes tools that are interoperable across phases of the program, across disciplines, inter program and inter service. An architecture and infrastructure must be available that supports the necessary exchanges of ideas and data, there must be repositories to store and manage data and a digital product description repository and finally the system engineering analysis necessary to make such an enterprise a reality. With its need for data sharing, disclosure, consensus building, expansion of decision making from independent stove piped disciplines to multi discipline cooperation, industry and government as team members, sharing of models and simulations, the collaborative enterprise will become a reality only if the *organisational, cultural and behavioural changes* from how we do business today to SBA occurs. SBA is a challenge to existing culture. HBR models for inclusion in SBA are necessary to support decision-making in the SBA collaborative environment.

The potential benefit of modelling the organisational and cultural change lies in the interest of NATO and multinational collaboration within NATO (e.g. collaboration of the armaments divisions of the nations). It can be expanded to any modelling and simulation effort, when large organisations are going to be restructured, thus prototyping changes, which otherwise would require organisational life experiments.

2.4 Support to Operations

This section starts with a description of the targeted commands and agencies and application area "Support to Operations" regarding the implementation of Human Behaviour Representation (HBR) and ends with requirements and recommendations for the use of HBR in support of this application area and.

2.4.1 Targeted Commands and Agencies

The following levels are targeted for the analysis: NATO Political Structure, e.g. North Atlantic Council, Strategic Commands, e.g. SHAPE and SACLANT, Regional Commands, e.g. AFNORTH, Joint Sub-Regional Commands, e.g. JCCENT, Component Commands, e.g. AIRNORTH, Multi-National Forces, e.g. AMF(L), International Organizations (IO), e.g. UN and OSCE, Non-Governmental Organizations (NGO) e.g. Red Cross, Private Voluntary Organizations (PVO) e.g. Doctors w/o borders. This is a full list of target audience in representing human behaviour in simulation models. In the following section the various application areas will be reviewed.

2.4.2 Description of Application Areas

The integration of simulation with C3I systems and the use of simulation in operations will help decision making in operational situations. Human Behaviour Representation is an essential part in such a system to provide support in situational awareness and course of action generation. The commander will be able to make decision at a faster pace with the benefit of HBR tools.

For different aspects of operations and mission type that is being conducted, there is a requirement for different HBRs. The following aspects of operations and types of missions were considered:

Aspects of operations:

- Contingency Planning (development and assessment of OPLANs.)
- Situation assessment (assessment of threat, own forces, environment, etc)
- Deployment Planning (force generation, movement and deployment)
- Sustainment and Logistics planning (Forces and supplies)
- Rehearsal (Dry run of specific mission)

- Current Operations (real-time monitoring and re-planning, decision making support to commanding, controlling and managing of operations)

Mission types:

- NATO Article 5 Missions (Defence of NATO territory)
- Crisis Response Operations (CRO)
    - Peace Support Operations (PSO)
        - Peace Keeping (PK)
        - Peace Enforcing (PE)
        - Conflict Prevention (CP)
        - Peace Making (PM)
        - Peace Building (PB)
        - Humanitarian Operations (HO)
- Other Security Interests (OSI)

2.4.3 Examples

Rehearsal for Article 5 operation determined to be one of the highest priority requirements for implementation of HBR. In Article 5 scenario it would be very advantageous for NATO commands to rehearse its missions in a tailored simulated environment. The various elements of such a simulation are composed of: opposing side/factions. political and military leadership, Political constituency, subordinate forces and terrorists.

Another aspect that needs to be considered are the friendly forces, composed of higher, lower and lateral commands, political leadership and the constituency. Finally, other participants such as refugees, NGOs, PVOs, IOs, neutral countries and media need to be included. In addition the following functions has to be represented: combat forces, combat support and combat service support as well as C3I.

Current operations are also determined to be a high priority requirement for simulation support and implementation of HBR. In current operations higher, lower and lateral command levels needs to be modelled. The other elements of opposing side and factions, friendly forces, other participants and representation of combat units and related C3I are the same as above example.

Situation assessment is another high priority operation to be considered for HBR implementation. The elements that may be represented are: Data collection, analysis and fusion, evaluation and distribution of information on opposing, and friendly forces. The environment needs to be represented as well. In certain situations there is a need to raise alerts and to manage C3I interactions.

2.4.4 Conclusions and Recommendations

In the application area of support to operations contingency planning, situation assessment, rehearsal and current operations are of high priority for Article 5 and Peace Enforcement missions. Deployment planning and sustainment and logistic planning are of high priority as well for Article 5 operations.

The two areas of high priority which are analysed in paragraph 1.3.5 regarding the underlying components concerning the needed functionality and consequential requirements are stated for each area below.

Current Operations Article 5 Missions

The following assumptions were made regarding the nature of Current Operations in future Article 5 Missions:

- The pace of decision making in Article 5 Missions must be changed dramatically in the future in order to conduct operations before the opposing side is able to react in an ordered way ("fight within the enemy decision cycle").
- Current Operations as basic function will change in this respect from only monitoring to performing tasks that are at the moment handled within Contingency Planning (e.g. re-planning).
- The amount of information and the availability in real-time will increase dramatically.
- Distribution and execution of orders will be much faster to take advantage of a faster decision making.
- The size of staff and forces will be reduced.
- Decision support is needed from the highest military level down to platoon level.

In this context, the following functions should be supported by HBR in Current Operations for future Article 5 Missions:

- Real time option generation to support decision-making.
- Rehearsal (of generated options) using state of the art simulation technology with HBR to get an insight in possible courses of actions.
- Rapid Analysis (of rehearsal results) to support the selection of a course of action.
- From this, the following consequential requirements are found:
- The integration of simulation model and HBR in the operational environment (C4I) is essential.
- The interoperability of national systems plays a major role in conducting combined (multinational) operations.
- The mutual understanding of the planning process at all command levels is necessary.

Current Operations Crisis Response Operations Peace Enforcement Missions

The following assumptions are made regarding the nature of Current Operations in future Crisis Response Operations Peace Enforcement Missions.

- These missions have an increased political dimension.
- There are different concepts of employment, allocation of assets to non-military priority tasks and objectives.
- The objectives are different and more ambiguous in comparison to Article 5 Missions.
- The pace of the decision making process will be rapid.
- At the start of such a mission establishment of the information base is necessary. At this time some basic information may be missing.

- The information (amount and availability) in real-time will increase dramatically (after establishment of the information base).

- The distribution and execution of orders will be also much faster in order to get the maximum advantage of this layout.

- The size of the staff and the forces will be reduced.

- Other nations than NATO nations may be part of the force (Non NATO Troop Contributing Nations NNTCN).

- Training Level, C2 Culture, Procedures, Tactics and Doctrines, Hardware might differ from NATO.

- The engagement area might be different from the usual environment (Terrain, Weather, etc.) in the old scenario.

- Decision Support is needed from the highest military level down to platoon level.

In this context the following functions should be supported by HBR in Current Operations for future Non Article 5 Major Conflict Missions:

- Real time option generation to support decision making including the following features:

    - Explanation capability (the system is not a black box and can explain its findings to the user to get a better acceptance)

    - Distributed Co-operative Planning: All echelons of decision making participate in developing a satisfactory solution in parallel. Complete coherent plan could be generated and synchronised (future systems should support this to enable users to plan in a distributed environment as well as to support HBR to doing so)

- Quick Rehearsal (of generated options) using state of the art simulation technology with HBR to get an insight in possible courses of actions based on the own planning.

- Rapid Analysis (of quick rehearsal results) to support the selection of a course of action.

- From this, the following consequential requirements are found:

- Applicable systems must be rapidly adaptable (learning) regarding the used rules and doctrine.

- The integration in the operational environment (C3I) is essential.

- Interoperability between national systems must be rapidly attained. Because of changing coalitions between nations for this type of mission a requirement for perpetual interoperability between all nations is not realistic.

- The operational procedures have to be adapted to new capabilities gained by HBR (e.g. co-operative planning) and must be trained.

- A mutual understanding of the planning process and the doctrines is necessary. This requires rapid training.

3 Summary of Importance of HBR

3.1 Instruction and training

The goal of instruction and training is to learn new skills and improve specific skills in individuals and teams. In order to support these tasks, it is necessary to develop a model of the subject of the instruction and training (the trainee or group), a model of the instructor and models of the inanimate systems, other human or human-operated platforms that the trainee(s) interact with. The model of the instructor includes evaluation or performance measurement models and models of the various strategies that can be applied to achieve the knowledge transfer objectives. All these models are required for any form of instruction and training. In order to automate these models, they need to be made explicit and it is necessary to develop a suitable framework for human behaviour representation.

Given the growing need to provide effective training, the limited resources available to achieve the knowledge transfer objectives and the increasing complexity of military tasks, the need for automated formal representations of human behaviour is becoming pressing. The availability of the various models described above is essential to support the concept of providing instruction and training for individuals and for teams on an any time, anywhere, on demand basis.

It will also allow the same training standard to be achieved in less time through a better evaluation and feedback capability and through the application of more diverse scenarios.

An improved level of training will also benefit the effectiveness of live training since individuals and teams, trained in simulated environments, will start with an increased skill level. Considerable associated side benefits are the reduced impact on the environment and the increased effectiveness of deploying costly resources. Live exercises will actually become more cost-effective because richer scenario's containing more elements of the environment can be addressed in terms of personnel, artificial and natural components.

The availability of an automated instruction and training environment that includes effective models of the trainee(s), the instructor and the elements of the real world that they interact with will allow continuous training to take place. It would provide every individual and team performing a military task to benefit from a virtual instructor that is continuously monitoring performance and that can provide a just-in-time rehearsal capability.

An effective instructional environment with consistent performance measurement could contribute to the selection and retention of suitable military personnel. Indeed explicit models of human behaviour for specific functions constitute a consistent reference for the selection of personnel that are capable of matching the model's characteristics. As discussed in para 3.2.1, developing good models of human behaviour is critical in achieving this objective and may be of considerable benefit to many NATO nation's armed forces where this problem is widely encountered. It may also contribute to the retention of personnel by providing a more varied and challenging training environment.

3.2 Exercises

Exercises are aimed at maintaining and applying acquired skills. They also serve to generalise knowledge and increase the ability of individuals and teams to select and apply suitable knowledge. Exercises are key to the development of knowledge concerning the application of skills, also referred to as meta-knowledge. They typically require substantial interaction with other teams and the deployment of large numbers of personnel acting as exercise facilitators in the form of directing and response cell staff. In exercises, the emphasis shifts from instruction and training to a form of peer-level coaching. The availability of automated representations of the behaviour of the individuals and teams that the exercising personnel interact with, will allow exercise settings to be composed in a more flexible, modular manner. It will also allow the environment to behave overall in a more consistent manner by removing biases due to level of training and experience of augmentation personnel. Given that the representations have been developed for interoperability and scalability, variable levels of granularity could be mixed to provide the appropriate level of information during the exer-

cises. This is a critical aspect in providing effective interfaces between the exercising environment and the C3I systems used by the exercising staffs.

The consistent behaviour of automated representations and their ability to record actions and information flow will improve the ability to provide feedback resulting in an improved capability for after-action review.

Finally, automated representations of human behaviour will result in a reduction in staffing levels for response cell, other forces and directing staff functions. It will also allow the environment to be used for other purposes e.g. acquisition and decision support. It must also be mentioned that a simulated environment containing these representations of human behaviour will enable the exercising of situations that cannot be created in a live exercising environment.

HBR is a critical enabling component for many NATO activities. In fact, the lack of adequate HBR has been described as a serious limiting factor for many of the types of simulation studies that NATO wants to conduct (NATO M&S Master Plan reference goes here). NATO requirements are changing. NATO is being asked to conduct many new and challenging operations. These new changing missions and threats require advanced modelling capabilities in several areas:

- NATO needs better models of individuals. Such models are needed to improve the quality of instruction, training, and exercises, ensuring that all trainees receive the highest quality instruction at a minimum cost.

- NATO needs better models of organisations and organisational behaviour. Such models are needed to investigate alternative command and control structures that would better support CRO missions such as peace keeping and humanitarian relief. Further, such models would support studies on information warfare and operations.

- NATO needs new classes of models to analyse geopolitical change. Such models are needed to analyse future NATO force and mission requirements.

Advanced HBR models are needed of individual and organisations at multiple levels of resolution, or fidelity. High fidelity models are needed for team training and information warfare analysis, for example. Lower fidelity models are needed for system acquisition analysis, for example. The need for models will most likely exceed NATO countries capability to build models. The challenge is to define a research program that maximises the return on investment so that the maximum number of needs can be addressed.

The return on investment from investing in HBR research is likely to be quite significant. HBR research is already generating new types of applications, spin-offs, to include the automation of tasks normally executed by human controllers in response cells (in command post exercises) and the development of intelligent interfaces that enhance situational awareness by continuously monitoring and fusing information from C2 systems.

4 References

Dompke, U., Scheckeler, K., Final Report on Long Term Scientific Study (LTSS/SAS-017) on Human Behaviour Representation (HBR) Technology, RTO-TR-047, AC/323(SAS-017)TP/25, Brussels, 2001

Human Behaviour Representation Applications

Dr. Uwe K.J. Dompke

NATO C3 Agency

This slide has been deliberately left blank

Diapositive intentionnellement blanche

Topics

- **Future Military Environment**
- **Military Applications**
- **Requirements**

Notes for Slide 2

The **Logical or Functional Perspective**. This view focuses on the logical or functional interrelationship of the CAX System Components and constitutes the **Functional Architecture of the CAX System**. The Functional CAX Architecture described in 1 is derived from military operational needs and it is not constrained by any system topology or other CAX System Implementation considerations.

The **CAX System Topology**. This view defines and evaluates available options for providing the CAX functionality. As the first step in this process, six options are identified, each with a different degree of integration of CAX with CCIS and with a different degree of distribution of the CAX functionality itself. The second step is then to compare the CAX Architectural Options and come up with advantages and disadvantages of each of them. This analysis, provided in Section 2, is based on the Functional Architecture as well as on a set of assessment criteria such as User Satisfaction, Implementation/Operation & Maintenance Cost, Security, Technological Trends and Flexibility.

Notes for Slide 2 (Continued)

The **CAX System Physical Architecture** describes hardware and software components and their interrelationships for the CAX system. In future CCIS, as in other modern information systems, this physical architecture will not play the role it is playing today. New technologies available to implement functions on distributed systems and global data links will make it possible to concentrate on the functional and topological design of the systems. Even changes from one physical architecture to another regarding the distribution of functions in a network will be no major problem and will give the opportunity to decide on topological architectures as described in chapter 2 in accordance with the exercise requirements. Chapter 3 introduces the discussion on possible implementation options for the different topological CAX architectures.

This slide has been deliberately left blank

Diapositive intentionnellement blanche

Future Military Environment

- **NATO's first mission is still Article 5 Operations**

- **Crisis Response Operations (CRO)**
  - **Potential crisis regions, their security impact on Alliance nations and routes to these nations**
  - **Peace Support Operations (PSO)**
  - **Other Security Interests (OSI)**

Notes for Slide 3

OSI: Potential threats to Alliance vital interests can result from a number of causes. Such risks are not geographically limited to areas in the areas contiguous and peripheral to NATO territory. These include:

(1) Military significant violation of arms control treaty obligations, including non-proliferation agreements.

(2) Threat to use military force, including coercion.

(3) Acts of terrorism or sabotage affecting Alliance territory.

(4) Disruption of economic lifelines, lines of communication, public service infrastructure by blockade, sabotage or other use of force.

(5) Border violations and incursions as well as hostile violations of Alliance territorial waters and airspace.

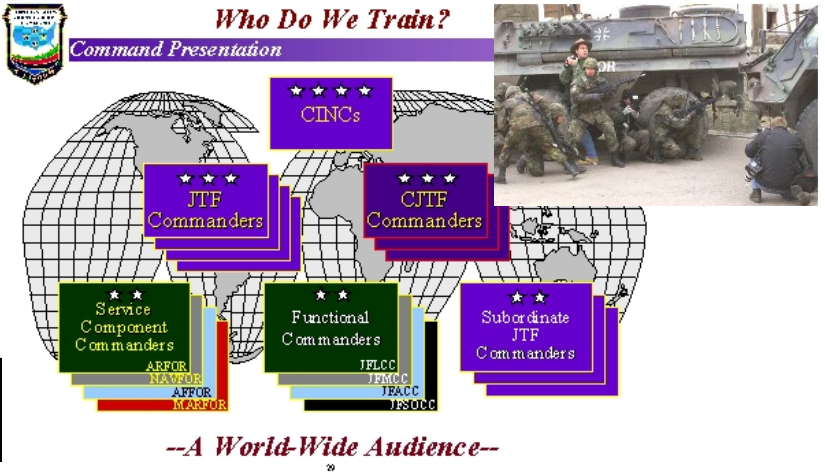
(6) Missile or aircraft attack against Alliance members.

(7) Spill over of conflict from beyond NATO's Area of Responsibility (AOR).

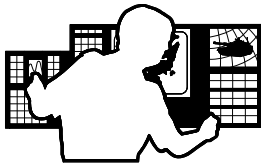
(8) Armed attack against forces, vessels or aircraft of any NATO member in NATO's AOR or beyond NATO's AOR during PSO.

Military Applications

- **Instruction, Training, Exercise**

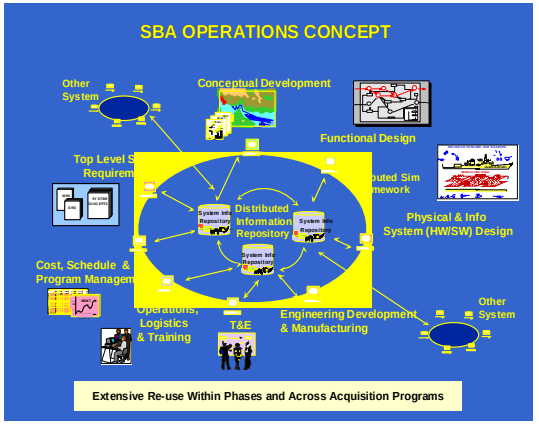


- **Defence Planning**



- **Support to Operation**

- **Acquisition**



Requirements

- **Technical**
- **Organizational**
- **Operational**

Technical Requirements

- Evolutionary Systems Development
- Composability (Component Based Systems)
- Interoperability (Is HLA the answer to all questions?)
- Scalability (Adjustment to Force Levels)
- Integration with CCIS
- Federated Databases (ATCCIS and follow-on systems)
- VV&A

Organizational Requirements

- **Data and Information Exchange**
  - **Research and Developer Community**
  - **User Community**

Data and Information Exchange

- **Preplanned and Structured Data Collection and Analysis Always a Mission Goal**
- **No Restricted Systems, Publication of Methods and Algorithms**
- **Public Databases As a Basis for Published Results**
- **National Restricted Databases As Supplement**

Organizational Requirements

- **Data and Information Exchange**
  - **Research and Developer Community**
  - **User Community**
- **Development Strategy and Standards**
- **M&S Components Repository**
- **Shared Scenario Databases**

Operational Requirements

- **Application Independent and Application Dependent**
  - **Instruction, Training, Exercise**
  - **Support to Operations, Operational Planning**
  - **Defence Planning**
  - **Simulation Based Acquisition**
- **Main Question:**
  Simulation Layout Regarding Human Players and Computer Simulation and Their Interaction

Application Independent (High Level)

- **Representation of the Real World (Fidelity and Level of Detail Depends on Application)**
  - **Conceptual Model (Task Analysis, …)**
  - **Analysis of Empirical Data (Including Lessons Learned)**
  - **Measures of Effectiveness, …**

Representation of the Real World for CRO

- **Multi-sided Models**
- **Situational Awareness**
- **Urban and Guerilla Warfare**
- **Information Operations**
- **Small Scale Contingencies**
- **Humanitarian Relief**
- **Organizations**
- **Civilian-Military Cooperation**
- **...**

Instruction, Training, Exercise

- **Automated Instruction and Training Environment**
  - **Effective Models of the Trainee(s),**
  - **The Instructor and**
  - **The Elements of the Real World That They Interact With**

Instruction, Training, Exercise - Benefits

- **Environment Behaves Overall in a More Consistent Manner**
- **Exercise Settings to Be Composed in a More Flexible, Modular Manner**
- **Interoperability and Scalability Will Allow Variable Levels of Granularity to Provide the Appropriate Level of Information**
- **Reduction in Staffing Levels for Response Cells, Other Forces and Directing Staff Functions**
- **Improved Capability for After-action Review Through Consistent Behaviour of Automated Representations and Their Ability to Record Actions and Information Flow**

Defence Planning

- Forecast Possible Security Environments
- Political-Military Decision Making
- Joint Operations
- Evaluating New Missions
- Military Expertise
- No Accepted Validation Methods

Support to Operations – Applications of HBR

- **Deployment Planning**
  (Force Generation, Movement and Deployment)
- **Sustainment and Logistics Planning (Forces and Supplies)**
- **Contingency Planning**
  (Development and Assessment of OPLANs)
- **Rehearsal (“Dry-run” of Specific Mission)**
- **Situation Assessment (Assessment of Threat, Own Forces, Environment, Etc)**
- **Current Operations (Real-time Monitoring and Re-planning)**

Acquisition

- **Great Need in the Design of Future Systems to Increase Mission Capability While Reducing Manpower Requirements and Overall Cost**

- **Challenge Is to Concurrently Design New Organisations, Equipment, and Human Tasks in a Radically Different Context**

Acquisition (LTSS WG – "Our 2 Cents Worth")

- To Enable SBA, We Need to Change Organizational Behavior
- To Implement This Change, We Need to Understand Organizational Behavior
- We Need "Tools" for Analyzing and Representing Organizational Behavior